MB T1000
SWEPT SPECTRUM ANALYZER
SYSTEMS & APPLICATIONS

MB ELECTRONICS A DIVISION OF TEXTRON ELECTRONICS, INC.

T1000 SWEPT SPECTRUM ANALYZER SYSTEMS & APPLICATIONS

In vibration and acoustic tests, spectrum analysis is needed on a continuous real-time basis to monitor equalizer performance. This lets the operator introduce immediate corrective action, when necessary. Speed is the overriding consideration in these "quick-look" analyzers, and such performance parameters as flexibility and accuracy must be sacrificed to obtain it. The better "quick-look" analyzers are suitable as preliminary editing tools for the recorded results of the tests, to determine the portions of the data on which to do a more detailed and precise analysis. Such analyzers as the MB T491 and SA-80/25 can be used for this purpose, particularly if there are large amounts of data involved.

For the final detailed analysis, speed is not of paramount importance, with prime considerations being accuracy over a wide range of conditions and requirements, and adaptability to many techniques. The T491 and SA-80/25 analyzers are of the parallel type, using 48 and 80 filters, respectively, as the frequency-selective elements. The basic data spectrum covered is from 5 cps to 2 KC; heterodyning techniques are used to displace the filter set by multiples of 2 KC, to permit any spectrum up to 10 KC to be covered. In multiple-filter analyzers, some compromises must be made to keep them from becoming excessively costly. Although they are excellent "quick-look" instruments, incorporation of the additional flexibility and performance required for the final detailed editing and analysis job would make them exceedingly complex and expensive.

In designing a spectrum analyzer to provide the best possible performance while staying within a reasonable price range, MB engineers chose the swept spectrum form of analyzer, employing only one filter per channel (see Figure 1). All the necessary complexity, flexibility and sophistication, together with the high quality of componentry required to achieve this purpose, can be lavished on the single channel, where it would be prohibitive in a multi-channel design.

In the swept spectrum analyzer, the signal to be analyzed is heterodyned in the modulator by the output of a sweeping oscillator. The analyzing filter extracts that portion of the resulting signal whose frequencies lie within its pass band, and its output is detected and averaged. As the oscillator sweeps over the range of signals of the input signal, the analyzer output displays the spectrum as a function of frequency.

The high accuracy and wide dynamic range of the T1000 Swept Spectrum Analyzer make it useful even as a means of calibrating other wave or spectrum analyzers. Other features that appeal to operators of the T1000 are its ease of use and flexibility. Set-up time, including accurate calibration of both spectrum and frequency, is less than two minutes.

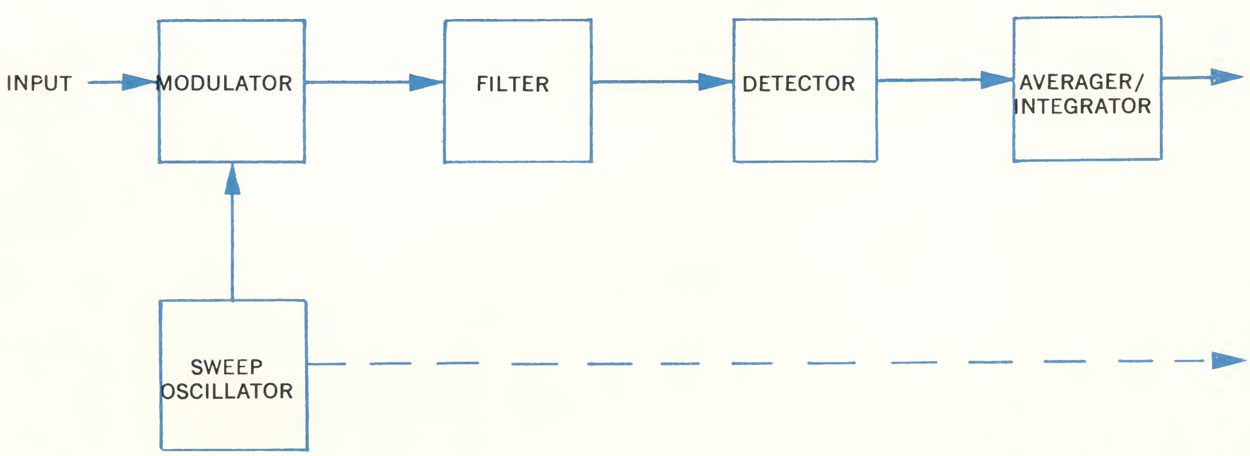

FIGURE 1. SWEPT SPECTRUM ANALYZER GENERAL ARRANGEMENT.

T1000 BASIC SPECTRUM ANALYZER

The basic T1000 Swept Spectrum Analyzer System consists of an N901 Analysis Control Chassis, an N902 Voltage-Controlled Oscillator Chassis with an integral Linear Ramp Generator, and an N903 Analysis Filter Chassis. The chassis are of all solid-state modular design, each with its own power supply, and they can be furnished mounted in a cabinet (see cover and Figure 2) or for rack mounting.

The basic system constitutes a versatile test instrument that allows examination on a laboratory basis of any signal input within its range of DC to 40 KC, and provides the desired data on the frequency components and their respective amplitudes. It can be used for power spectral density analysis, sine tracking, wave analysis and Fourier series. In addition, transient signals can be analyzed, and residual shock spectrum analysis can be performed on the input signal. The system allows direct analysis of the response of an unlimited number of infinite-Q single tuned circuits to residual shock pulses recorded individually on a tape loop.

The accuracy of the system is such that it can be used as a calibrated standard for analysis, with any of the 19 filters provided in the N903 chassis as the standard. Its versatility is shown by the many modes of operation possible. There is a choice of two types of data input, one with and one without filtering through a 500 cps low pass filter, to enhance the dynamic range at low frequencies. There is also an internally generated calibration signal input. Four output detectors are provided: a true squaring or power detector, to allow readout of true power from the filter, regardless of signal characteristics; an average or linear detector, for full dynamic range of detection; a true RMS detector that provides the independence of calibration of the squaring detector with the dynamic range properties of the average detector, and a peak detector

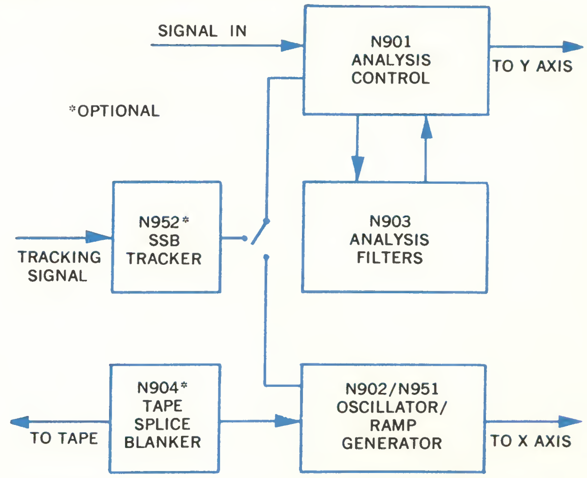

FIGURE 2. BASIC MODEL T1000 SWEPT SPECTRUM ANALYZER BLOCK DIAGRAM.

for transient and shock analysis. The 19 filters provided in the standard N903 Filter Chassis allow front panel selection of band widths ranging from 2 to 200 cps. The 7-pole Butterworth filters used eliminate the stability problems of crystal filters, making possible the stability of calibration of the T1000, which is guaranteed for at least a month. Data can be read out by any of the conventional means, and even further flexibility can be gained for the T1000 by use of the optional equipment available.

The T1000 Systems are designed for ease and convenience of use, with large manual controls and easy-to-read dials. Particularly useful to the operator is the read-out window that gives a color-coded indication of full-scale output, type of detector selected, normalization, if used, and type of output-smoothing. A red warning light comes on if a selection incompatible with the system has been made, or if the output is not calibrated.

OTHER SPECTRUM ANALYZER SYSTEMS

In addition to the basic T1000 Spectrum Analyzer, other analyzer systems, for either more limited or more complex analyses, can be made up by substituting chassis in the basic system, or adding chassis to it. Diagrams of some modified systems adapted to specific types of data analysis, and brief descriptions of their application, are given below.

T1002 SIMPLIFIED ANALYZER SYSTEM

For those who do not require the full performance capabilities of the basic T1000 Analyzer, this system (see Figure 3) allows performance of power spectral density analysis, sine tracking and wave analysis. It does not have the accuracy or resolution of the basic analyzer, and can not perform transient or residual shock analysis. It does, however, provide superior performance as a tracking-filter type analyzer.

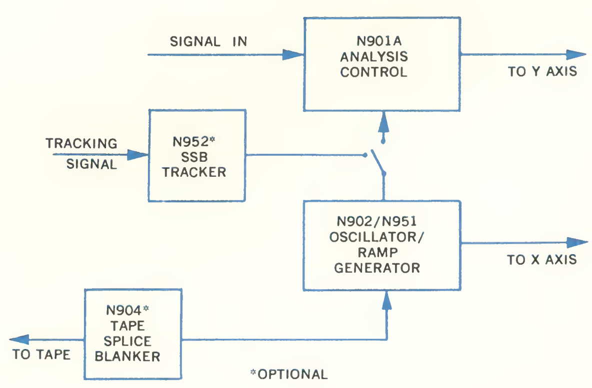

FIGURE 3. SIMPLIFIED ANALYZER SYSTEM, MODEL T1002.

TRANSMISSIBILITY RATIO DETERMINATION

This analysis technique allows the investigation of the response characteristics of an unknown design by examining the ratio of the output to input signals, ignoring phase. It lets the design engineer examine the effects of an unknown system on the input voltage (Y_{in}) as a function of frequency. With this information, he can make some predictions about system performance.

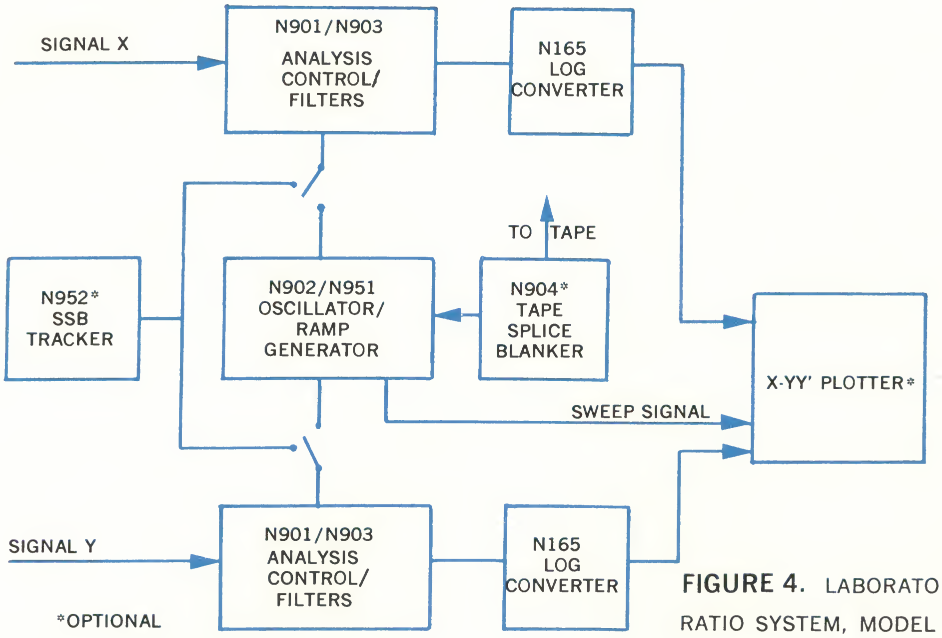

FIGURE 4. LABORATORY TRANSMISSIBILITY RATIO SYSTEM, MODEL T1003.

T1003 LABORATORY TRANSMISSIBILITY RATIO SYSTEM

The system diagrammed (Figure 4) provides an accurate, versatile tool for the analysis of the response of a test item to the application of a signal, whether the input signal is sine, random, periodic, shock or transient. It affords the maximum analysis capability to the engineer interested in transmissibility ratios.

T1004 SIMPLIFIED TRANSMISSIBILITY RATIO SYSTEM

Figure 5 shows a tracking filter approach to providing a transmissibility ratio plot. The system is useful for sine and random tests, but does not have the accuracy or resolution of the laboratory system. Accuracy is high enough in sine and random cases to allow investigation of the transmissibility of the test object in either real time or from tape loops.

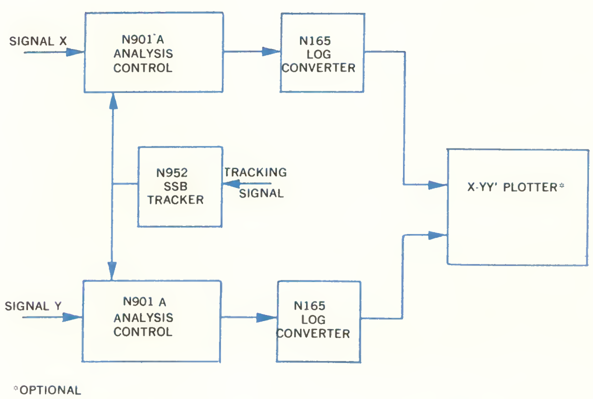

FIGURE 5. SIMPLIFIED TRANSMISSIBILITY RATIO SYSTEM, MODEL T1004.

SHOCK AND TRANSIENT PHENOMENA

It is often necessary to know the frequency composition of both shock and transient signals in order to predetermine the effect of applying these signals to a system. This analysis is also necessary to those performing shock tests to assure the application of the required shock spectra to the test specimen.

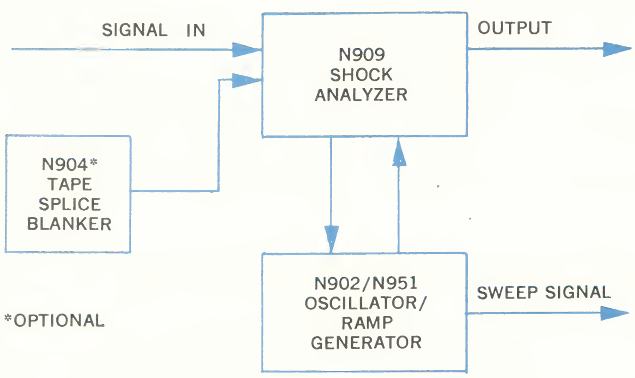

FIGURE 6. SHOCK SPECTRUM SYSTEM, MODEL T1005.

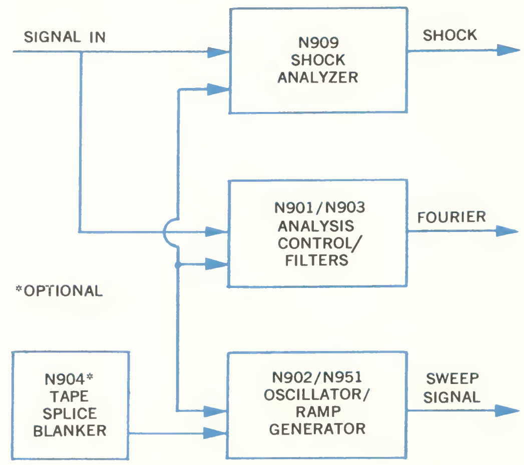

FIGURE 7. TRANSIENT SPECTRA SYSTEM, MODEL T1006.

T1005 SHOCK SPECTRUM SYSTEM

Although the basic T1000 tystem will perform residual shock spectra analysis, this system (see Figure 6) is designed to provide a complete shock spectrum analysis including positive, negative, primary and residual shock spectra. It is designed for an economical approach to the problem, providing the response of a single tuned, adjustable Q-circuit to the shock signal. The function is provided together with the standard analysis features for a more universal system approach.

T1006 TRANSIENT SPECTRA SYSTEM (FOURIER/SHOCK)

This system (see Figure 7) provides the maximum function single channel analysis system. It allows the analysis of a wide variety of single input signals: sine, random, periodic, mixed sine-random, transient and shock. The outputs available, dependent on the signal input and the operating modes, are Fourier series, Fourier transform, PSD, and shock spectra.

TRANSFER FUNCTION AND IMPEDANCE DETERMINATION

Both transfer function and impedance data are invaluable to the design engineer. They allow him to verify his design as well as provide him with information for design improvement, or for future new designs. These data provide both amplitude and phase information (in either polar or rectangular coordinates) about any "black box" design.

T1007 TRANSFER FUNCTION/UNIVERSAL IMPEDANCE COMPUTER SYSTEM

The T1007 Transfer Function/Universal Impedance Computer System makes use of the same chassis with different interconnecting circuitry (see Figures 8 and 9). The Transfer Function System provides the capability of cross spectrum analysis as well. The resultant output signal may be obtained in either polar or rectangular coordinates. Another important feature is that the system will operate equally as well on transient and shock signals as it will on sine, random, etc. The unit can also be used as a dual channel spectrum analyzer, as can the other multi-channel systems described.

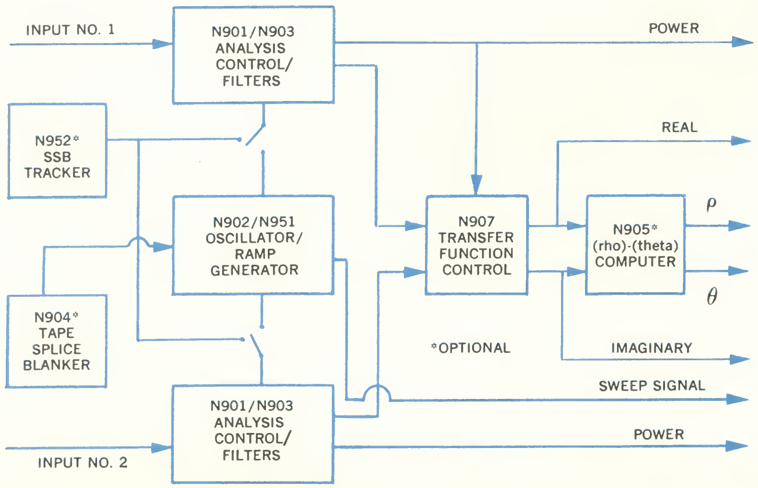

FIGURE 8. CROSSED SPECTRUM AND TRANSFER FUNCTION ARRANGEMENT OF MODEL T1007.

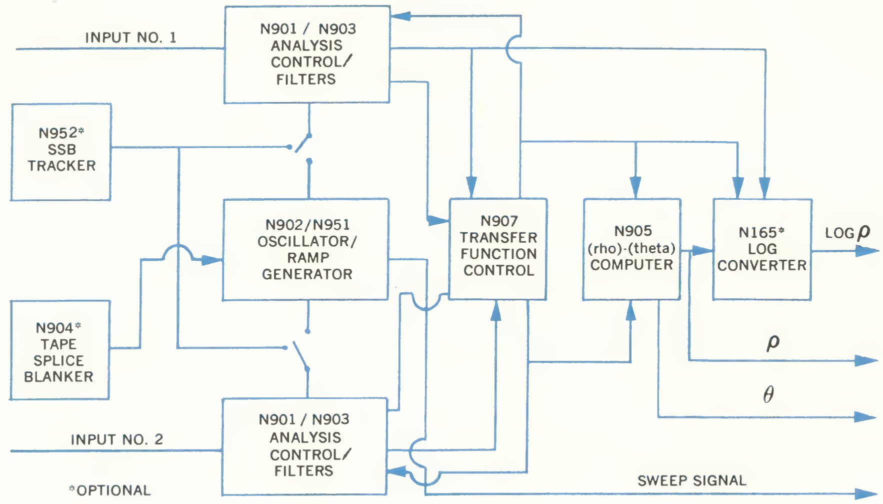

FIGURE 9. UNIVERSAL IMPEDANCE COMPUTER ARRANGEMENT OF MODEL T1007.

The Impedance Computer System is described as "Universal" because it can be used to compute impedance information from shock, transient and random, as well as from sine inputs. This system will automatically provide impedance information in the polar form, or as log rho (ρ) with phase angle theta (θ). A simplified version, using a tracking-filter approach and limited to sine signals, can also be made available.

SPECIFICATIONS

It should be noted that as the basic T1000 Swept Spectrum Analyzer is the heart of all the systems described above, the specifications for that system, as given in MB Bulletin 214, apply to all of these systems as well.

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PRINTED IN U.S.A. 2M-6-66 BULLETIN 500